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ADDRESS

*Delivered by the President, Captain W. de W. Abney, C.B., R.E.,
D.C.L., F.R.S., on presenting the Gold Medal to Dr.
Isaac Roberts.*

THE Medal of the Royal Astronomical Society has been awarded to Dr. Isaac Roberts, F.R.S., for his photographs of star clusters and nebulae. It is always a congenial task for the occupant of this chair to explain the reasons why the choice of the Council has fallen on any distinguished astronomer, and more especially so when it happens that it falls on one of our own Fellows. On both occasions on which I have occupied this chair the choice has so fallen. Last year my remarks were addressed to a consideration of the eye observations carried on for many long years by a single observer; this year the eye has to hold a subordinate place, giving way to the photographic plate as a recorder. The latter is a recorder in which there can be no systematic personal error as regards the relative positions of objects which cannot be discounted; and though photography in some particulars does not always speak the truth, yet for a study of the heavens its retina is capable of receiving more accurate impressions than that sensitive surface which lines the eye, and which transmits a message to the brain, more or less tainted with preconceived notions. Your retiring President is in a position to fully appreciate the magnitude of the work undertaken by Dr. Roberts. A thirty-two years' experience in every past or present photographic process has impressed deeply on his mind the remarkable strides that the science of photography has made since he first developed a wet plate. It seemed then to be amongst the improbabilities that a surface should ever be prepared which should be rendered so exquisitely sensitive to light that it could be with advantage employed by the astronomer who wished to make a register of the heavens. Most of the members of this Society who are photographers have only probably studied the "new photography," if it may so be called, which had its birth when Bennett showed that a salt of silver (the bromide) when suspended or emulsified in gelatine could have imparted to it, by long warming at a moderate temperature, a sensitiveness which was twenty to thirty times that of the same salt when

used in the ordinary wet process. The success thus achieved was not at the time fully appreciated, except by some few earnest workers, to whom the further improvement of the photographic plate naturally fell. The long heating at a gentle warmth took the place of the more brutal process of boiling the liquefied gelatine, and even heating was found to be unnecessary when strong liquid ammonia was added to it. Long were opinions divided as to the advantages of the hot over the cold preparation of the sensitive material, and I am inclined to believe that to the present day a diversity of opinion exists. But with improvements such as these a picture of a portion of the heavens, which Rutherford took eight minutes to obtain, can now be secured in a quarter as many seconds ; and it is possible by very prolonged exposure to secure images of stars which have never been seen, though after their positions are known the eye is able to glimpse them in some of the largest telescopes.

The photographs by Common of the great nebula in *Orion* were epoch-marking in astronomical photography, and worthily was the medal bestowed on him for his classic work, and it is no disparagement of the labours of the present recipient if one traces in them the mark of what Common had shown to be possibilities. Dr. Roberts may have been said to have commenced his labours, which we are now considering, nearly ten years ago, for in 1885 April he had constructed for him by Grubb a 20-inch silver on glass reflector of nearly 100 inches focal length. As naturally to be expected when applying an instrument to a novel purpose, some defects in its mounting were found, and some short time elapsed before it was in such working order as to enable him to produce his first series of satisfactory negatives. This telescope, we are told, Dr. Roberts intended to use for charting the heavens on a scale twice that which Argelander adopted in the *Durchmusterung* ; but when the International Congress was called together by Admiral Mouchez in 1887 he decided to devote it to another, though kindred, field of work, which also lay well within its capabilities ; viz. the photography of star clusters and nebulae. It is for the exploration of this field that the Council has awarded to Dr. Roberts the highest honour it can confer ; and when we consider what such an exploration means, one will not doubt that this honour has been worthily and properly bestowed. The work was first carried on near Liverpool, but your Medallist became dissatisfied with the conditions which surrounded his observatory, and concluded that for a more rapid and satisfactory progress he must move to some place which gave better atmospheric conditions. Careful investigation showed him that the highest ground in the neighbourhood of Crowborough gave him what he required ; and on Crowborough Hill he erected his observatory and remounted his telescopes, and from that time he has made his photographs there. Like Dr. Huggins he has a reflector and a refractor on the same mounting, the former being used

for photographic work, and the latter for visual observations : both are driven by one clock in Right Ascension, but they can be moved independently in Declination.

Speaking as a Fellow of the Society, and not as the mouth-piece of the Council, I cannot but congratulate Dr. Roberts on arriving at the conclusion that a reflector is better for his purpose than a refractor. The value of the identity of focus for all the spectrum components, and the possibility of having a ratio of aperture to focal length so large as 1 to 5, give the reflector an advantage which it is difficult to overrate. Star discs, when the reflector is properly figured, must be nearer theoretical perfection, and therefore are *not* exaggerated in size for large magnitudes. Dr. Roberts tells us, however, that the adjustment of a reflector is much more difficult than that of a refractor, and this may be well believed ; but the extra trouble involved is well expended when one looks at the splendid results achieved, which are now placing him so prominently before the Society.

One of our Fellows and my immediate predecessor in this chair has perhaps unwittingly given the best proof of the excellence of the results by his measurements of the star discs taken with Dr. Roberts's reflector, and of those taken with refractors. He has shown that the images are much smaller with the former than with the latter, though the apertures employed in both cases are not such as to account for the difference from causes of diffraction.

In the report of the progress of the work carried on at the Crowborough Observatory, which has just been submitted you, occurs the following sentence which is worthy of special notice :—

“ Some considerable portion of the autumn months was occupied in testing the new triple objective of 6-inch aperture, made by Messrs. T. Cooke & Sons. The lens proved to be *perfectly* ‘achromatic,’ no trace of secondary colour being visible around even the brightest objects. The visual and photographic foci were found, from a great number of careful experiments, to be exactly coincident, as in a reflector.”

It may be that in an instrument such as this, the reflector will have a serious competitor in one respect for object-glasses of moderate sizes, but it may be doubted if it will ever be rivalled in the work which requires the utmost light-gathering power.

Turning to the absolute work that the Medallist has carried out, it should be stated that he commenced photographing the stars with various photographic lenses in 1883. The paper in which he recounted what he had done is found in the *Monthly Notices* of 1886 January. Each year since then he has contributed to the *Monthly Notices* papers on the subject of the research which he undertook, interspersed with others bearing upon stellar photography. In 1886 December he produced a photograph of the nebula in *Orion* with his 20-inch reflector, with an exposure of 15 minutes ; and almost exactly two years

after he produced a photograph of the same object with an exposure of 81 minutes, and introduced us to nebulosities in the surrounding parts which were unsuspected before. Other photographs of the same object, with more prolonged exposure, can be also remembered. A little afterwards he produced his recently published photograph of the great nebula in *Andromeda*, giving an exposure of 4 hours to the plate. In this prolonged exposure we have an example of a triumph of patience, and of instrumental perfection, though these qualities are exhibited in other instances as well. This beautiful object is depicted with its rings of nebulosity in great perfection, and we can correct the eye observations which had previously been made on it. The stars in the field are beautifully sharp and round, showing that the eye as well as the instrument had to be employed throughout that long exposure to correct changes in position of the star due to atmospheric refraction, and variations in the rate of clock-driving.

About this photograph Dr. Roberts says : "This photograph will remain a permanent record, unquestionable in accuracy, of the state or the appearance of the three nebulae (there are two others on the plate), shown on the night when the photograph was taken, so that any changes in the form or density of the nebulosity, or in the positions or magnitudes of the stars, will in future be capable of demonstration." In 1891, it may be remarked, he did actually discuss the photographic evidence of variability in the nucleus of his great nebula.

He adds : "These photographs throw a strong light on the probable truth of the Nebular Hypothesis, for they show what appears to be the progressive evolution of a gigantic stellar system."

How many stellar photographs he has taken it would be rash to endeavour to state, but some idea of their minimum number may be formed when it is stated that in the last three reports of the work done at the different observatories inserted in the annual Report of the Council, we find that at Crowborough, about 160 plates are recorded as having been successfully exposed. Nor can I venture to estimate the researches he has carried on as to the value of different brands of plates for his purpose. The astronomical photographer has to experiment largely on commercial wares before he begins his serious work. These experiments are not publicly recorded, and hence the labour involved can only be appreciated by those engaged in similar work. In Dr. Roberts's case the experiments were neither few nor far between. It is only by patient work of this kind that advances in our knowledge of the heavens can be obtained.

Last year our Medal was awarded to a gentleman who had wonderfully increased our knowledge of double stars by his laborious and unobtrusive work ; and this year we are recognising the same kind of labour expended in bringing before us an acquaintance with those beginnings of systems which it was the privilege of but a few to scan imperfectly. Thanks to the skill which has made the 20-inch mirror, it is an obedient servant

instead of a tremulous slave, and its proper and systematized use has enabled the student of the universe at his leisure, and in the warmth of his study, to gaze at and scrutinize these ever-beautiful and mysterious objects, instead of seeking some one of them for some few hours on the finest of nights and in the cold midnight air. The solution of problems of the highest import in cosmical science is thus rendered far easier, and the thanks of all who interest themselves in such researches are due to those who, with such indomitable persistency, devote much of their time to pushing scientific discovery into those far-off regions of space.

I have not alluded to any other work which Dr. Roberts has carried out, though I might have mentioned his method of making direct engravings on plates from his negatives, a process which is certainly valuable and extremely ingenious. So far photography seems only to be limited by the physical features of the plate itself. Under the microscope the sensitive salt is a mass of small grains on which the image is received, and, as in the case of the cones in the retina, it is doubtful if a separation of two bright points is possible when they both fall on the same grain. The developed image is also a mass of small grains of probably very nearly pure metallic silver, and it may be doubted whether this also does not limit the application of photography in separating star discs very close to one another; but up to this limit, where grain becomes an important factor, it certainly has been used to the utmost by your Medallist. What the possibilities of the future may be, it would be somewhat rash to speculate. That something much more sensitive and much more homogeneous than the existing forms of silver salts as formed on a plate may be discovered seems a remote possibility. But, as I have pointed out elsewhere, the possibilities of a colour sensation being evolved must have seemed remote to our very early ancestors, who merely felt the sensations of light and form; and we must not take it as proved that nothing superior to a photograph, such as we know it now, may in the future be evolved. Be this as it may, Dr. Roberts's photographs, if they are preserved as they should be, will live to tell their own tale of what exists at the present time to students in centuries to come. That they will in our own days be rendered accessible as far as possible is proved by the issue, in June last, of that remarkable volume containing permanent prints of stars, star clusters, and nebulae enlarged to a scale to show 24 seconds of arc to one millimetre, and in some cases but 6 seconds of arc. I cannot do better than quote the concluding paragraphs in its preface, which I had not read till I had penned my Address to this point.

"The photographs portray portions of the starry heavens in a form at all times available for study, and identically as they appear to an observer aided by a powerful telescope and clear sky for observing.

"Absent are the atmospheric tremors, the cold observatory,

the interrupting clouds, the straining of the eyes, the numbing of the limbs, the errors in recording observations, and the many hardships incurred by our predecessors, of glorious memory, in their attempts to see and fathom the ILLIMITABLE BEYOND.

“I commend the observations and the photographs herein to astronomers and students of the New Astronomy.”

This last sentence your President re-echoes, and it gives him the greatest pleasure to hand to the Secretary for Dr. Roberts the Gold Medal of the Royal Astronomical Society, with the heartfelt wish that many more of our meetings may be enlivened by the beautiful pictures of the Heavens which he exhibits for our benefit, and which will be of inestimable value to those engaged in that branch of science which the Royal Astronomical Society was formed to foster.